

Photographic Bait Stations

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Introduction

There are a variety of systems in use that employ a camera at a bait station to detect wildlife. We will describe three that are widely used and with which we are most familiar. They can be divided into two major categories according to the type of camera used. The first employs automatic, 35-mm cameras and can be further divided into two types that differ by the mechanism that triggers them. We will refer to these types as “single sensor” (Kucera and Barrett 1993, 1995) and “dual sensor” (Mace and others 1994). The second major category is a line-triggered system that uses a manual, 110-size camera (e.g., Jones and Raphael 1993). We provide data on equipment costs and discuss the relative merits of the various systems in a later section of this chapter.

Remote-camera systems are currently available from several manufacturers (e.g., Cam-Trakker, 1050 Industrial Drive, Watkinsville, GA 30677; Compu-Tech Systems, P.O. Box 6615, Bend, OR 97708-6615; Deerfinder, 1706 Western Ave., Green Bay, WI 54303; also see Bull and others 1992, Laurance and Grant 1994, Major and Gowing 1994, Danielson and others 1995).⁴ All employ somewhat different configurations and have different advantages and disadvantages. The cameras used in these systems also change as camera models are discontinued by manufacturers and new ones are introduced. Thus, the systems we describe in this document may differ from what is available in the future, and the reader who wishes to use remote photography to detect wildlife may need to modify specific procedures as appropriate for the equipment in hand. As remote-camera technology advances, it is likely that additional designs will continue to be developed.

Single-Sensor Camera System

The single-sensor system that we will describe here is the Trailmaster TM1500 (Goodson and Associates, Inc., 10614 Widmer, Lenexa, KS, 66215, 1-800-544-5415), which consists of an infrared transmitter and receiver, used with the TM35-1, an automatic, 35-mm camera (*fig. 1*). The camera is triggered when an infrared beam is broken; such an occurrence is termed an “event.” The transmitter emits a cone of infrared pulses. Because the receiver has an area of sensitivity of about 1 cm in diameter, the effective beam diameter is about 1 cm, thus requiring precise placement to intercept the target animal. The transmitter and receiver may be placed as far as 30 m apart. Their alignment is facilitated by a sighting groove on the receiver and a red light that flashes during the setup procedure to indicate that the beam is being received; this light stops flashing when the system is in data-collection mode.

The receiver also is an event recorder that stores the date, time, event number, and whether a picture is taken each time the beam is broken. A maximum of 1000 events can be stored. The sensitivity of the trigger—that is, the length of time the beam must be broken or, more accurately, the number of infrared pulses that must be blocked to register as an event—can be adjusted by the user from 0.05 to 1.5 seconds. The time

Description of Devices

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⁴The use of trade or firm names in this publication is for reader information and does not imply endorsement of any product or service by the U.S. Department of Agriculture.

after a photograph is taken until the next can be taken (the “camera delay”) also is set by the user, from 0.1 to 98 minutes. If the beam is broken during the camera delay, events are still recorded and stored. The transmitter and receiver are each powered by four alkaline C-cells, which last approximately 30 days of continuous field operation. Both units come with nylon straps about 70 cm long for attachment to trees.

The most recent (November 1995) Trailmaster configuration employs an Olympus Infinity Mini DLX camera; earlier models used a Yashica AW Mini or an Olympus Infinity Twin. These camera changes were dictated by the availability of the models from the manufacturer; users of the equipment must become familiar with the operations of the particular camera they have. The components of the different systems, such as receivers and cables, are not interchangeable and should not be mixed up. The camera is modified to be triggered by an electrical pulse from the Trailmaster receiver. A quartz clock in the camera allows display of date and time on the photograph. The camera connects to the receiver with an 8-m wire, providing flexibility in the placement of the camera. Several cameras can be triggered simultaneously with the use of an optional multi-camera trigger. The flash can be operated automatically as required by available light, in fill-in flash mode so that the flash operates with every frame, or the flash can be turned off. With 100-ASA film, the flash illuminates to about 3.5–6 m, depending on the camera model; with 400-ASA film, this distance is doubled. Infrared film also may be used with an infrared filter over the flash. Slave flashes, triggered by the flash of the camera, can be used to extend the area illuminated.



Figure 1—Single-sensor equipment. From left to right: transmitter, receiver, and camera. Above the camera is the metal shield that protects it. Immediately below the camera is a ball-and-socket head bolted to a metal L-bracket for attachment to a tree; below that is the “tree-pod” that comes with the system. The camera is attached to the receiver with an 8-m wire.

The Olympus Infinity Mini DLX in the newest Trailmaster configuration can use either one 3-v lithium or two AA alkaline batteries. In normal use, the lithium battery will operate through about 14 rolls of 36-exposure film, and the alkaline batteries about 10, assuming flash on half the exposures. At a bait station, because the camera is constantly on and the flash is charged, the battery may last only 30 days. The quartz clock is operated by the camera battery. The capacitor that charges the flash in the Olympus Infinity Twin camera used in earlier models drains after 2-4 days if no photograph is taken. Thus, if the camera is not triggered, or is not reset by closing and opening the lens hood during this time, the flash may fail to operate the first time the camera is triggered. This does not happen with the Yashica, which keeps the flash charged at all times. However, the batteries in the Yashica must be changed more frequently. The Olympus Infinity Twin uses two 3-v lithium batteries, which will last through approximately 20 rolls of 36-exposure film, assuming the flash operates on half the frames. The Yashica camera uses 2 AA batteries, which last approximately 2 weeks. The quartz clock is operated by a separate 3-v lithium battery that will last 3 years.

The system comes with a 10-cm, collapsible, plastic tripod with a threaded ball-and-socket head that screws into the bottom of the camera. A metal bracket shields the top and back of the camera and prevents birds from pecking the controls while allowing access to the viewfinder; the metal bracket also provides some protection for the lens from rain or snow if the camera is operated in landscape format. The tripod is designed to be placed on a flat surface, or when collapsed, attached to a small tree or branch by a Velcro strap. The attachment of the camera to a tree or other support can be greatly improved by using a more substantial ball-and-socket head purchased at a photographic supply store (the Bogen model 3009 works well), attaching this to a metal "L"-bracket with a bolt, and fixing the bracket to a tree with lag bolts (*fig. 1*). This is a much more secure and convenient alternative.

The entire system weighs about 2 kg with batteries, and can be transported in a 25- × 20- × 10-cm box. It is weatherproof and operates in rain and snow. We tested low-temperature operation of an early model using the Olympus Infinity Twin in a freezer, and it performed consistently at -17 °C for 2 weeks and at -7 °C for 2 more weeks.

Also available from the manufacturer (Goodson and Associates) is a device that allows electronic collection of data (date and time of all events, and which events triggered the camera) in the field for later transfer to a personal computer; the data can also be transferred directly from the receiver to a personal computer. The collector is particularly useful when you check several stations in a day by reducing the time you spend recording data at each station. The software package required for downloading from either the receiver or collector provides output in the form of text (event number, date, time, and frame number) and a graph showing events by day and time in a 3-dimensional bar chart. Trailmaster also makes a battery-operated printer that produces a hard copy of the event data in the field.

Dual-Sensor Camera System

The dual-sensor remote camera system consists of an automatic 35-mm camera modified to be triggered by a microwave motion and a passive infrared heat sensor (Mace and others 1994; *figs. 2A, 2B*). Dual-sensor systems are made by Compu-Tech, Trailmaster, and Tim Manley (524 Eckleberry, Columbia Falls, MT, 59912, 406-892-0802). Although the Trailmaster TM500 dual sensor (*fig. 3*) has recently been field-tested and proved reliable and lightweight (K. Foresman, pers. comm.), we will describe the use of the equipment from the last source, sometimes referred to as the "Manley" camera. These three systems share many similarities. If you are using a dual-sensor system from another manufacturer, the procedures described below will need to be altered as required by the

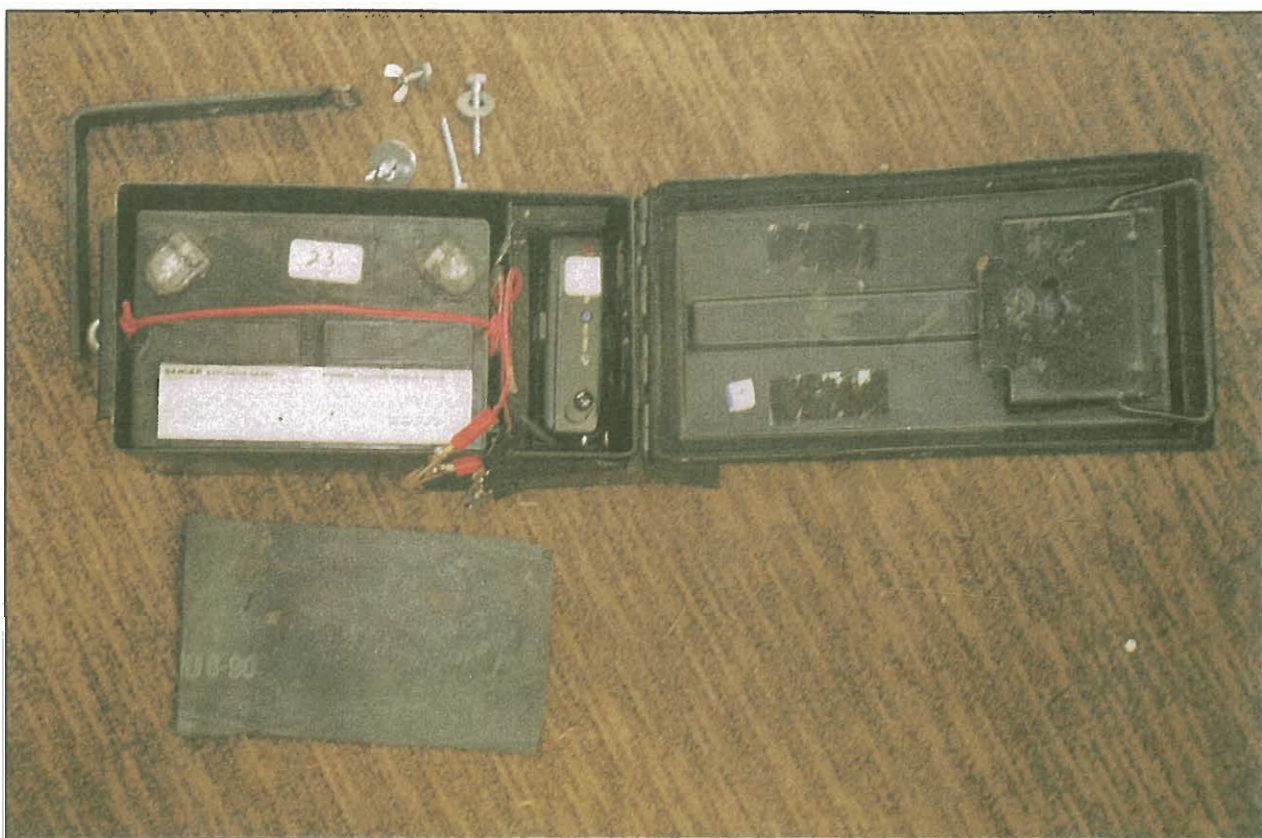


Figure 2A—Manley dual-sensor equipment (from above). Battery on left and camera on right.



Figure 2B—Manley dual-sensor equipment (from the front).



Figure 3—The Trailmaster TM500 dual-sensor camera system. From left to right: dual-sensor unit, camera, and metal camera shield. Immediately below the camera is a ball-and-socket head bolted to a metal L-bracket for attachment to a tree; below that is the “tree-pod” that comes with the system. The camera is attached to the receiver with an 8-m wire.

particular system employed. Again, because of the availability of particular camera models from the manufacturers, specific designs of the system are likely to change.

In normal operations, both the microwave sensor that detects motion and the passive infrared (PIR) sensor that detects changes in ambient temperature are triggered simultaneously and operate the camera. If either sensor malfunctions (e.g., the microwave sensor loses its signal, or if ambient temperature approaches the body temperature of a target animal), the other sensor will take priority and will work like a single-sensor system. Both sensors send out a field to approximately 11 m. The camera is triggered when an animal enters the field, which can be restricted to several meters wide by obstructing the PIR sensor window. The sensors draw 35 mA from the 12-v gel cell (golf-cart type), deep-cycle battery used to power the system. This rechargeable battery should last for 20 days between charges.

Early versions of this system used an Olympus Infinity Jr. camera, modified to be triggered by an electrical pulse from the sensor. The camera focuses from 0.7 m to infinity; the flash illuminates to 4.5 m with 100-ASA film and 9 m with 400-ASA film. The flash can be operated automatically as required by available light, continuously on every picture in fill-in mode, or the flash can be turned off. The capacitor that charges the flash drains after 3-4 days if no picture is taken. Thus, if the camera is not triggered or is not reset by closing and opening the lens hood, the flash may fail to operate the first time the camera is triggered. The camera is powered by a 3-v lithium battery that will

last through 20 rolls of 36-exposure film, assuming the flash operates on approximately half the pictures. However, because the light meter is on continuously while the remote camera is operating, the camera battery may last only 1-2 weeks depending on how many rolls of film are exposed, how many flash pictures were taken, and the ambient temperature. The camera is equipped with a quartz clock that allows displays of date and time on each photograph; the clock is powered by a 3-v lithium battery that will last several years.

The entire system is housed in a weatherproof 15- × 30- × 19-cm metal ammunition box that will withstand moderate abuse (e.g., from a bear) without being damaged. An external switch allows the system to be turned on and off without opening the box. The box can be modified to allow it to be locked shut and cabled to a tree to discourage theft and vandalism. The system comes with a mounting bracket and lag bolts for attachment to a tree. Total weight is approximately 13.6 kg including the 12-v battery.

Line-Triggered Camera System

This is an inexpensive, remotely triggered system, assembled by the user, that employs a 110-size camera (*fig. 4*). We have the most experience with the Concord 110 EF and CEF with internal, electronic flash (a distributor can be contacted by calling 908-499-8280), but similar models may be satisfactory. It is essential that the camera have an internal flash; “flash bars” and “flash cubes” have a high failure rate in the field. Each camera should be identified with a unique number engraved or written on the body with permanent marker.

The system is composed of the camera, a wooden mounting stake, a cover from a plastic gallon milk jug, an external battery pack, and the trigger mechanism. The mounting stake is a 1- × 3- × 36-inch post topped with a 0.05- × 2.75- × 5.0-inch wooden platform (*figs. 5, 6*). The platform should be firmly screwed to the top of the post because this is the surface on which the camera is attached. Avoid using plywood for the platform.

The camera can be adequately weather-sealed for most conditions by putting a strip of electrical tape over the trigger release and a second strip over the flash switch area (*be sure the switch is ON*). However, in rainy conditions, the camera should be covered with

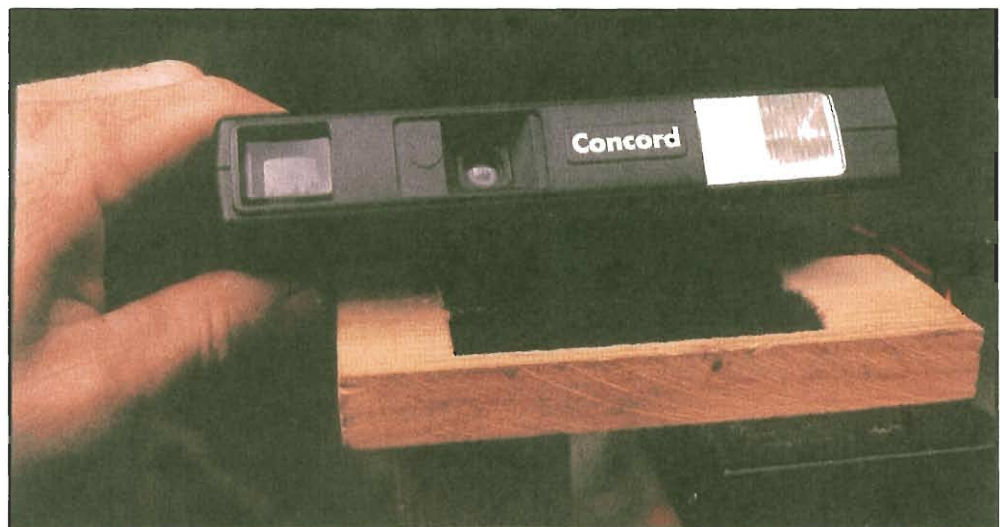


Figure 4—110 camera, raised from platform to view Velcro attachment.

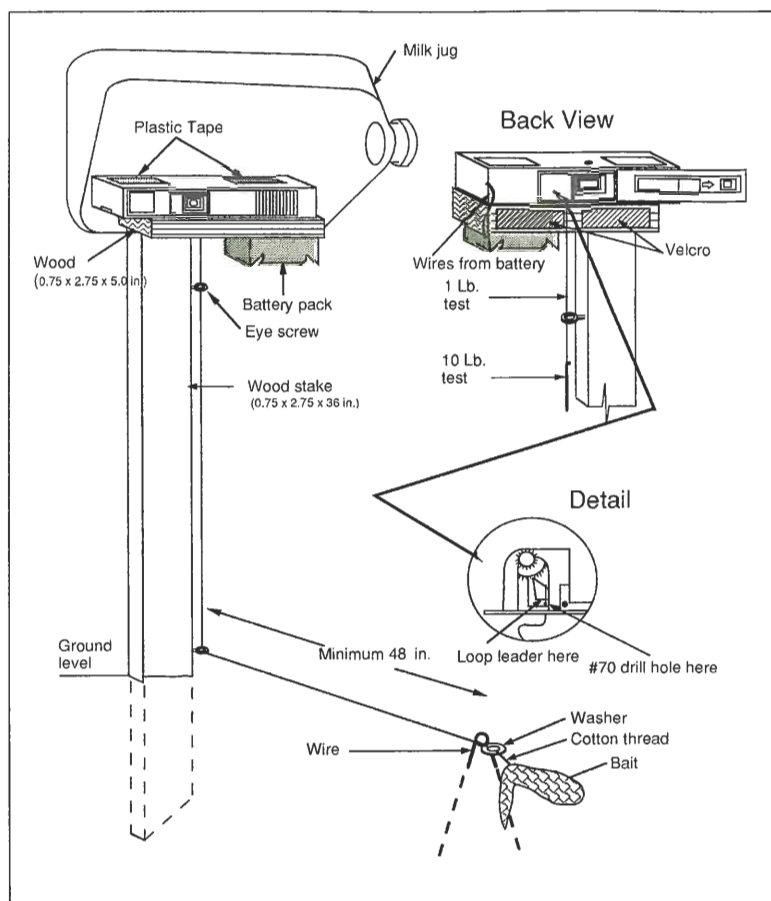


Figure 5—Schematic configuration of a line-triggered camera station.



Figure 6—Line-triggered camera station. Protective milk jug in place.

half of a 1-gallon milk jug (*fig. 5*). Staple Velcro to the milk jug and to the vertical surface of the platform board to hold the jug in place. Position the Velcro pads to avoid obstructing the nylon leader that comprises the trigger mechanism (see below) as it exits the camera. Camouflage the jug with dark green or brown spray paint to reduce the chance of its discovery by passers-by.

Unlike previous versions in which a coat-hanger-wire mechanism triggered the shutter (Fowler and Golightly 1993, Jones and Raphael 1993), the design presented here employs a line from the bait that connects directly with the shutter mechanism *inside* the camera (L. Chow, pers. comm.). Familiarize yourself with how the 110 camera works by opening the rear of the camera and watching inside while tripping the shutter and operating the film-advance mechanism several times. Look for a flat, triangular lever that snaps backwards when you trip the shutter. This is the internal shutter release. Trip the shutter to disengage the internal shutter release from the toothed gear. Drill a small hole (using a #68 or #70 gauge drill bit) in the underside of the camera, approximately 2 mm from the rear edge of the camera. Position and angle the hole so it is just behind the internal shutter release. Make a loop in a 12- to 15-inch length of a 2-lb test nylon fishing leader. Fold and pass the loop through the hole and, using forceps, hook it over the internal shutter release. Secure the loop by knotting it outside the camera an inch or two from the hole; a knot inside the camera may prevent the shutter release from operating properly.

Because the factory-suggested batteries for the camera are insufficient to provide energy for more than a few days, additional power must be provided. Build an auxiliary battery unit that will house two size D batteries (*fig. 6*). House the batteries in a standard, open, plastic battery pack, available at electronics stores. The D-cell unit should be connected to the battery terminals in the camera by stereo wire that is soldered from the battery pack to the contacts in the camera battery compartment; if wires are provided with the battery pack, use them. The Concord 110 requires very little modification to solder the wires to the battery terminals in the camera's battery compartment. After soldering the wires, cut a small hole in the camera's battery compartment door to allow entry of the wire from the auxiliary battery unit. Seal this hole with silicone. The battery compartments of other camera brands (e.g., Vivitar and Focal) require that some of the plastic body be cut away to access the internal battery terminals. Attach the battery pack to the bottom of the platform board with short screws or rubber bands; Velcro is inadequate to support the weight of the batteries.

Baits and Lures

Recommendations:

With the 35-mm systems, we recommend using road-killed deer, fish, or a combination of the two. The amount used should be as large as possible, up to a whole deer carcass, but at least 5 kg. With the line-triggered system, chicken wings are the recommended bait. Also use a commercial lure and, especially for surveys for lynx, a visual attractant (e.g., hanging bird wing, large feather, or piece of aluminum).

Mustelids

Wolverines, fishers, and martens are opportunistic hunters, and the great diversity in their diets reflects this (Banci 1989, Hash 1987, Martin 1994). In addition to taking live prey, they frequently scavenge in winter and can be attracted to carcasses of ungulates (Hornocker and Hash 1981; Pittaway 1978, 1983). Thus, road-killed deer (*Odocoileus* sp.) are probably one of the most readily available baits to attract these species to 35-

mm camera stations. However, because it is illegal to handle or transport road-killed deer without appropriate permission, coordination with the state game agency is necessary before handling and transporting them.

In many areas, road-killed deer are available seasonally; this may require planning in order to have bait for the field season. Storing deer can be a challenge; a large freezer such as at fish hatcheries or cold box at some National Forest System ranger districts often is necessary. The bigger the bait the better, but handling whole deer carcasses can be difficult. An important requirement is that the bait be large enough to remain attractive until it is scheduled to be replaced. We recommend a piece of road-killed deer weighing at least 5 kg. One approach to increase the convenience of storage and transport of bait is to quarter deer when fresh and freeze the pieces in individual plastic bags. The frozen packages can be transported when needed, eliminating the need to cut up frozen carcasses. Another attractant being experimented with is cow blood, frozen in gallon milk jugs, from a slaughterhouse. Putting an anticoagulant in the blood will keep it in a liquid state. At the camera station, perforate the jug to allow the scent to escape and suspend the jug from a cable, approximately 3.5 m above the ground.

Commercially available trapper lures such as skunk scent may be valuable to attract the mustelids, and we recommend that they be tried and evaluated in conjunction with the bait. Two sources of such lures are the M & M Fur Company, P.O. Box 15, Bridgewater, SD 57319 (605-729-2535) and Minnesota Trapline Products, 6699 156th Ave. NW, Pennock, MN 56279 (612-599-4176). Standard predator-survey disks containing fatty acids can be obtained from the Pocatello Supply Depot, 238 East Dillon St., Pocatello, ID 83201. In several areas of California, fish emulsion sold as fertilizer in garden-supply stores and used in conjunction with deer carrion has been used to attract fishers and martens. Brands vary in the strength of their odor. Mixing vegetable oil or glycerin with the fish emulsion may retard evaporation and thus extend the attractiveness of the scent.

Lynx

Lynx rely heavily on a single prey species, the snowshoe hare (*Lepus americanus*), although they do take other small mammals, birds, and carrion, particularly when hares are rare (Hatler 1989). This requires somewhat different strategies in attempts to detect them. The typical set used to trap lynx employs a scented lure (e.g., commercially available skunk scent and some catnip) in addition to a visual attractant or “flasher” such as a grouse wing, a turkey primary feather, or an aluminum pie plate on a string above the trap (Baker and Dwyer 1987, Geary 1984, Young 1958). Once attracted to the general area by the scent, the animal sees the object moving in the wind and comes to investigate it. A similar arrangement could be used to attract lynx into the beam of the single-sensor, or within the range of the dual-sensor camera. Scents are probably best purchased from a commercial supplier. A set employing carrion, a scent, and a bird wing conceivably could attract any of the four target species.

Recommendations:

35-mm systems: Conduct surveys in winter. Bears are least active during winter, and the dual-sensor cameras operate best in cool temperatures.

Line-triggered system: Conduct one survey in the spring, shortly after snowmelt, and if the target species is not detected, conduct another in the fall. The line-triggered camera system works best in snow-free conditions.

Survey Seasons

Single and Dual Sensor

There is evidence that wolverines are more attracted by carrion in the winter than at other seasons (Hornocker and Hash 1981), and this is likely true of the other mustelids. They also may be less likely to come to an attractant when natural foods are more common. In addition, bears are usually much more numerous than wolverines, fishers, and possibly martens, and are readily attracted to bait. Bears can exhaust the film, remove bait, and damage equipment. For these reasons, the best season to try to detect mustelids is winter. However, data on wolverines in Idaho suggest that females restrict their movements from near the time of parturition through weaning of offspring and thus may be effectively removed from the population in late February and March (J. Copeland, pers. comm.). Similar seasonal considerations may apply to fishers (Arthur and Krohn 1991, York and others 1995) and American martens (Strickland and others 1982).

Both 35-mm systems operate well in the snow; the dual-sensor system operates best in winter because warm temperatures during the summer can send erroneous signals to the sensor. If working in winter is not possible, or if bears are active year-round in a particular area, you may need to check and move the equipment more frequently. If a bear finds a station, it is likely to return, so the station may need to be moved or reconfigured to prevent the bear from taking the bait (see below, Checking the Stations).

Seasonal differences in vulnerability of lynx to trapping are unknown, so recommendations for seasonal guidelines will have to await additional data. Again, however, if bears are a problem in a study area, or if there is an ongoing program of snow tracking (see Chapter 5) to detect lynx that can incorporate the photographic bait stations, winter would be the most appropriate season.

Line Trigger

The line-triggered camera system recommended here is difficult to use in snow, especially if snow falls during the survey period (C. Fowler, pers. comm.). Snow can interfere with the trigger wire that runs along the ground, and cold temperatures can affect the mechanical trigger. Therefore, surveys using line-triggered cameras should be conducted when most snow is melted and the risk of new accumulation is low. However, the line-triggered camera has successfully been used during winter by attaching the camera and bait to the top of a downed log that is above the snow (T. Holden, pers. comm.).

Martens and fishers have been detected on numerous occasions at line-triggered camera and track-plate stations baited with chicken during the spring, summer, and fall (Fowler and Golightly 1993; Seglund and Golightly 1993; Zielinski and others, 1995), when alternative foods are assumed to be more abundant than in winter. Bull and others (1992) detected marten at more stations in winter than summer, but only 16 stations were used. There is no compelling evidence that spring and fall surveys that target marten and fisher are less effective than winter surveys, and surveys certainly are easier to conduct in spring and fall. Neither wolverines nor lynx have been detected at line-triggered cameras, so conclusions about seasonal effects on their detectability must await additional data. There is little evidence that bears will return as frequently to a line-triggered camera station as they do to 35-mm camera stations. There is no reason to believe that moving the station will result in less damage than replacing the unit at the same location. Because of its low cost, a line-triggered camera set damaged by bears does not result in significant expense.

Survey Duration

Recommendations:

35-mm systems: Operate each station until either the target species is detected *or* a minimum of 28 days have elapsed.

Line-triggered system: Stations should be set for a minimum of 12 nights and checked every other day for at least six visits (excluding setup) *or* until the target species is detected. If the target species is not detected during the first 12-day session, run a second session during the alternate season (either spring or fall) for at least 12 days *or* until the target species is detected.

Allow extra days to achieve the recommended duration if the camera becomes inoperative.

Because the objective of the survey is to determine whether the target species is present in a sample unit, effort need not be expended beyond the detection of the target species. The minimum duration that a 35-mm camera station should operate without detecting a target species is 28 days. We based this minimum effort on data on “latency to first detection” of wolverines and American martens. Using dual-sensor systems, J. Copeland (pers. comm.) detected wolverines at six stations with a mean latency of 38 days; the median latency was 17 days. Mean latency to first detection at dual sensor cameras in Montana was 13.5, 9.0, and 13.0 days for martens, fishers, and wolverines, respectively (Foresman and Pearson 1995). Kucera⁵ detected American martens at 25 single-sensor stations after a mean of 7.9 days and a median of 5 days.

We set the minimum effort when using line-triggered cameras at 12 nights in response to several sources of information on the latency to first detection for marten and fishers. In reviewing the results of 207 surveys that used either track plates or line-triggered cameras, Zielinski and others (1995) found that the mean (SD) latency to first detection for surveys that had from 6 to 12 stations was 4.2 (2.4) and 3.7 (2.6) days for fisher and marten, respectively. This estimate is biased downward, however, because it included only those surveys that detected a target species before the survey was concluded. Raphael and Barrett (1984) suggested that 8 days were sufficient to achieve high detection probabilities when measuring carnivore diversity at a site. Jones and Raphael (1991), however, discovered that 60 percent (3 of 5) of first detections during marten surveys occurred after day 8 but before day 11. They concluded that surveys should run more than 11 days. Fowler and Golightly (1993) suggested a 22-day survey duration, but this was with the intention of using track-plate visits to monitor population change. Because the objectives of detection surveys are different, and because the statistical merits of their approach have not been adequately addressed, 22 days is probably excessive for detection.

Because visits by lynx and wolverines to line-triggered camera stations have not yet been recorded, there are no data on which to base recommendations for survey duration. Until appropriate data are collected to suggest otherwise, we believe that the 12-day duration, twice per year if necessary, is sufficient effort.

⁵ Unpublished data on file at the Department of Environmental Science, Policy, and Management, University of California, Berkeley, CA.

Defining the Survey Area

Recommendations:

Conduct surveys in 4-mi² sample units, as described in Chapter 2.

Chapter 2 discusses the two types of survey, Regional Distribution and Project Level. The investigator should decide which type is appropriate for the planned work and outline the survey area on a map. In both types of survey, we recommend the use of separate, 4-mi² sample units as the basis of the survey. For a Regional Distribution survey, the region of interest should be defined on a map, and the 4-mi² sample units

Preparations for the Field

located as suggested in Chapter 2. A Project Level survey will include a 36-mi² area, with nine sample units, centered on the project.

Station Number and Distribution

Recommendations:

35-mm systems: Use a minimum of two cameras in each sample unit, no closer than 1 mile apart, at the sites of the most appropriate habitat or where unconfirmed sightings have occurred.

Line-triggered system: Use a minimum of six camera stations in each sample unit. Arrange stations in a grid, distributed at intervals of about 0.5 mile, at the site in the sample unit with the most appropriate habitat or where unconfirmed sightings have occurred (see Chapter 2, *fig. 2*).

Within each sample unit, place the detection devices (minimum of two 35-mm or six line-trigger cameras) where a detection is most likely. This could be in an area thought to have the most suitable habitat or near an area of previous reports of occurrence or likely travel routes, as discussed in Chapter 2. However, in doing so, try to maintain the inter-station spacings recommended above.

Two 35-mm cameras are an adequate minimum density per sample unit because they can operate longer for the same personnel costs than the line-triggered cameras, and the larger baits used should attract target individuals from a greater distance. The number of line-triggered cameras in a survey can influence its success (Zielinski and others, 1995). Although the data are too few to estimate the optimum station number, it seems reasonable to have detection stations that sample at least 10 percent of the area in the sample unit for the survey duration. Six stations provide at least 12.5 percent coverage of the sample unit if they are arrayed as a rectangle and one assumes that a target individual will be detected if it travels within the area created by joining the perimeter stations. Of course more stations will provide a greater assurance in detecting occupants, but more than 12 stations (covering 1.5-mi²; 37.5 percent of the area) would probably be excessive.

If there is no reason to place the line-triggered camera stations either at the most suitable habitat or where previous sightings occurred, array the stations as a grid in the center of the sample unit. Wherever the grid is placed, adjust its shape to accommodate road access in the vicinity. If the sample unit is roadless, pack the materials into the area.

In the Field

Before you go out, become familiar with the operation of the device you are using. Practice with it so that you are comfortable with its operation. When using the single-sensor system we describe, understand its commands, know how to program it, read out the event data, clear it, change batteries, and know where in the manual to look for instructions for a particular topic you need help on. This is *much* more easily done in the warmth of home or office than in the field.

In the field, do not go alone, especially during winter. Tell someone where you are going and when you will return, and what to do if you do not return by a certain time. Be aware of the weather forecast, have appropriate gear, and expect the worst. Remember that ease of access can change drastically as snow conditions change. Be sure you have all the necessary equipment; a list is provided below (Equipment List).

The major considerations for establishing stations in the field are maximizing the probability that they will be found by the target animal species and minimizing the likelihood that the station will be found by people. Mark the station permanently with a metal tag or stake, and precisely describe its location. If possible, use a Global

Positioning System to determine the location. This will allow future study efforts to replicate your work.

Winter Safety

Surveys using 35-mm cameras will be conducted primarily during winter when potentially hazardous conditions frequently exist. It is the responsibility of the supervisor to evaluate potential hazards in the survey area and to obtain proper training for all personnel before they go into the field. Field biologists often assume they know how to get along in the outdoors. Surveying for rare species during winter may test those assumptions; being a field biologist does not guarantee competence to conduct fieldwork in winter.

Job descriptions and training for field technicians should stress winter field skills including skiing, snowshoeing, snowmobiling, camping, and avalanche training. Proper winter equipment must be provided to each field person. Employees should be trained by in-house experts or at one of several established winter training schools. Lists of winter camping and avalanche training schools are provided in Chapter 5 under Safety Concerns. Two excellent references on avalanches are by Armstrong and Williams (1986) and Daffern (1992). Selected references on winter outdoor skills include Forgey (1991), Gorman (1991), Halfpenny and Ozanne (1989), Pozos and Born (1982), Schimelpfenig and Lindsey (1991), Weiss (1988), Wilkerson and others (1986), Wilkerson (1992), and Wilkinson (1992).

Handling Bait

Uncooked meat baits are a potential source of *Salmonella* bacteria, so meat should be wrapped in plastic and frozen until the day it is used. Contact with either fresh or old bait should be minimized. Plastic bags can be used as gloves to reduce contact, and for smaller pieces of bait, kitchen tongs can be used. Carry soap, water, and disposable wipes so that you can wash your hands thoroughly after handling bait. Careful attention to cleanliness will make the risk of contamination from rotting meat, including chicken, negligible (J. Sheneman, pers. comm.). The risk of poisoning the target species with rotting meat baits is very low, as most target species regularly consume carrion.

Station Setup

Single Sensor

A soft-sided cooler bag is convenient for carrying the Trailmaster and provides some protection. Be sure that the receiver is programmed for the correct date and time, for pulses = 10 (**-P 10**), and for camera delay = 2.0 (**cd 2.0**). These are initial recommendations; change them if you have reason. For example, make the trigger more sensitive (fewer pulses) if bait is being taken but no events recorded, or increase the camera delay if a non-target animal such as a squirrel is shooting up a lot of film. Make sure that the receiver is programmed to activate the camera (see the Trailmaster manual, p. 12). A short summary of Trailmaster commands is presented in *appendix B*.

Load film into the camera. Print film of 100 ASA works well, is relatively inexpensive, and can produce enlargements of acceptable quality. Using a small, blunt tool, synchronize the date and time on the camera display with the receiver, and set the display to show the date (day number) and time, not month or year or other configuration. With the Olympus Infinity Twin, be sure that the horizontal bar over the minutes digits is showing, which indicates that the information will appear on the film.

For mustelids, an ideal site has three trees, 15-30 cm in diameter and 3-10 m apart, lined up in a north-south direction with the middle tree slightly (15 cm) offset, and a

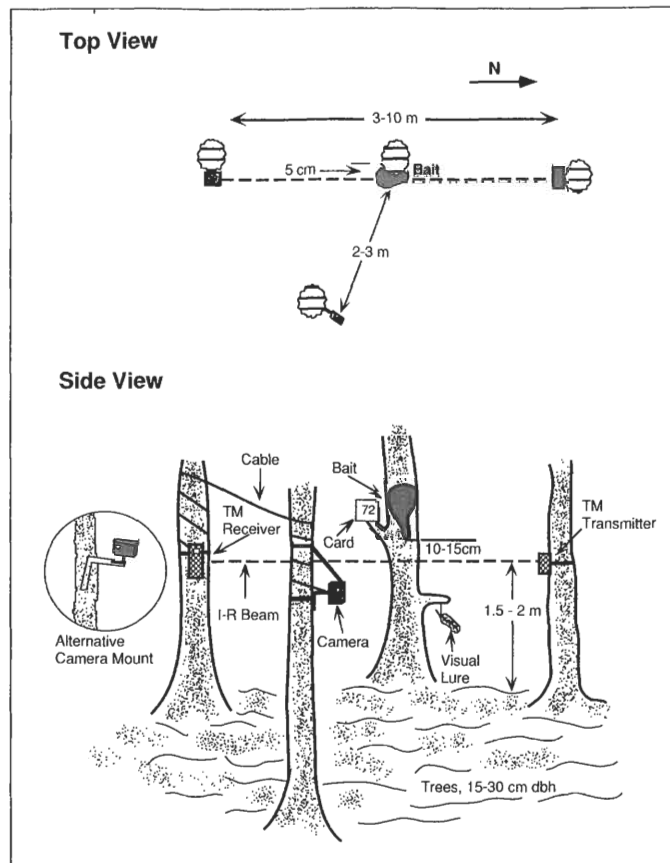


Figure 7—Schematic configuration of a single-sensor camera station.

fourth tree or a branch 2-3 m from the middle tree with a good view of it (figs. 7, 8). The transmitter will be in the middle of the trunk of the northernmost tree facing south, and the receiver will be on the east side of the trunk of the southernmost tree with the receiving window pointing north. This orientation is important to prevent solar infrared radiation from reaching the receiver and causing false events to be recorded. The bait will be on the middle tree, and the camera will be on the fourth tree. As an alternative, the camera can be above the receiver on the same tree. The beam should pass within 5 cm of the middle tree about 1.5-2 m above the ground. With some practice, you can easily identify the appropriate configuration of trees. Do not use trees that will move in the wind, and trim any branches that could blow into the beam or block the camera.

It is best to have one person handle the bait and another the equipment, so that no odors from the bait get on the equipment. Hang the bait along the trunk of the middle tree so that it is at least 2 m above the ground to prevent canids from reaching it. In areas of heavy snowfall, you may need to adjust the height of the bait to accommodate changing levels of snow. Attaching the bait to the tree with wire will prevent loss of the bait if the string or rope is chewed. Trim lower branches to guide animals to the bait through the beam and to eliminate perches for birds and squirrels in the beam. Add any scent as appropriate to attract animals to break the beam.

Position the transmitter on the northern tree and receiver on the southern tree so that the infrared beam passes 10-15 cm below the bait on the middle tree and about 5 cm from the tree, so that any animal climbing the tree to get the bait must pass through the beam. Look down the sighting groove on the receiver, and aim it *precisely* at the transmitter window; this is important for getting the best performance. When the approximate positions of the transmitter and receiver are established (using the receiver in setup mode with its flashing red light), tighten the receiver strap and check the alignment again.



Figure 8—Single-sensor station. Camera and receiver on tree on left, bait (deer leg) on central tree, and transmitter on tree on right.

Loosen the transmitter strap and tilt the transmitter up and down and side to side, watching when the red light on the receiver stops flashing. This is to determine where the central portion of the infrared beam is; fasten the transmitter so that this central portion of the beam hits the receiver. Check the position of the beam relative to the tree and bait by passing your hand through the beam to simulate an animal coming to the bait and watching when the red light on the receiver goes out, showing that the beam is broken. Remember, after 4 minutes the receiver automatically leaves the setup mode and the red light stops flashing. Again, sight down the groove in the receiver; adjust it so that it points directly at the transmitting window and tighten the strap, pushing the points on the back of the receiver into the tree so that the unit is firmly positioned. Visually check the transmitter to determine that the central portion of the beam is directed at the receiver, and adjust it if necessary.

If you are using the collapsible tripod supplied with the Trailmaster, attach the camera to it with the metal bracket shielding the top of the camera. Set the flash mode for **FILL-IN**, so that the flash operates on every exposure, and make sure that the self timer and continuous mode are off. Attach the camera and tree-pod to a tree or large branch about 2-3 m from the bait, with an unobstructed view centered on where you expect the animal to be. Position the camera so that the automatic focus frame in the viewfinder is on the target and not a distant background. The tree-pod should be collapsed; use duct tape to attach it to the tree. Tighten the attachment of the tree-pod to the camera, make a final alignment of the camera to the target, and tighten the ball and socket; this should be done with pliers to achieve a secure connection, but be careful not to strip the threads. A length of duct tape from the camera shield up to the tree helps prevent the camera from

tipping down when weighted with snow. As a more secure alternative, attach an L-shaped metal bracket to the tree with lag bolts to provide an attachment for a more substantial ball-and-socket head such as the Bogen 3009 (figs. 1, 7).

Run the camera cable from the receiver to the camera, winding it several times around the trees on which the camera and receiver are placed, so that any tugging on the cable (from snow, animals, you falling down) pulls on the tree and not the equipment. Be aware that the cables are specific for the model camera used and are not interchangeable. Be sure you are using the correct one. Run the cable at least 2 m off the ground so that animals and most people pass below it. Do not plug the cable into the camera yet. Trim any branches that could be in the field of view or interrupt the beam when weighted with snow or that could lift into the field of view as snow melts. Attach a blue, 3 x 5 card with the station's identification number written in large letters with a waterproof, wide-tipped marking pen to the tree in the field of view. The card provides a scale for measurement of animals in photos and a record of location. Avoid white cards, which often are overexposed and difficult to read on the photo. Attach a laminated card with the following message to a nearby tree, positioning it out of view except when close to the set:

This is part of an important wildlife study being conducted by _____. Please do not touch. It is an automatic camera that will take a picture of an animal as it comes to the bait, and will not harm the animal. If you have any questions, please contact _____. Thank you.

Finally, when you think all is ready, plug the cable into the camera and receiver, being sure the cable is plugged in correctly. Reset the event recorder to zero, run your hand through the beam where you expect the animal to be, and be sure a picture is taken and an event recorded. If they are not, check the programming of the receiver (p. 12 in the Trailmaster manual), the camera cable, or the alignment of the beam. Make sure everything is right, and remember the 2-minute camera delay: a picture will not be taken for 2 minutes after the last picture is taken. If necessary, reset the receiver to zero and try again.

Record in your field notebook the number of photographs taken during set-up, the final event number on the receiver, and the date and time of your test photo departure. This will be important information when you return to check the camera. A sketch of the set on the Survey Record form (appendix A and in pocket inside back cover) will help identify what configuration works and what does not. Be generous in taking field notes; these will be used in the future to reconstruct what happened, and to analyze what went wrong and right. Use flagging tape to mark the way to the site if necessary, but do not flag the site itself, to lessen the chance of its being found by people.

Dual Sensor

We will describe a station configuration that we have used with the Manley system. If you are using the Trailmaster TM500 or another dual-sensor system, modify the station as the equipment and reason dictate. Before going out, familiarize yourself with the camera and the other components of the system and how they work. The camera will operate without film so the system can be assembled in the office to make sure all components are working properly. Set the camera so that the day, number, and time are displayed and will be printed on each picture. Make sure you have all the equipment on the list provided at the end of the chapter.

An ideal site for the dual-sensor station is the intersection of several game trails. However, if deer densities are high, setting over game trails may produce too many pictures of non-target animals. Choose a site in a sheltered area, if possible, that will be shaded for most of the day. The camera unit produces the best pictures if it faces north. An area along the trail with three trees in a triangle will work best (*figs. 9, 10, 11*). The tree at a southern point serves to support the camera and should be 3.5-5.5 m from the target point. The two other trees support the cable holding the bait and should allow the bait to be at least 3 m from any tree trunk and hang over the trail or target point. Because the Manley dual-sensor camera operates as long as a warm, moving object is in its sensor field, the bait must be inaccessible. An animal should be attracted to the station but leave shortly because it cannot reach and feed on the bait. The Trailmaster TM500 requires setting a camera delay, which avoids exposing all the film in a short time.

Suspend the bait on 1/8-inch cable between the bait trees at least 3.5 m off the ground. Use 10-m cable pieces with looped ends that will allow the cables to be hooked together to reach the appropriate length. Using a climbing belt and either removable tree steps or climbing spurs, attach one end of the cable to one tree. Then climb the other tree, wrap the cable around it as many times as needed, and anchor the cable with a nail through the looped end. Remember to place the cable high enough so the bottom of the bait will be at least 3.5 m off the ground. The bait can be suspended by attaching a rigid wire hook to the bait, roping it up to the cable, and using a pole to push it out along the cable until it hangs over the appropriate target point. If you are using heavy baits, they can be suspended using a pulley system. Attach a pulley to the cable so that when it is strung, the pulley will hang over the target point. Before suspending the cable, tie a rope to the bait (using burlap sacks to contain the bait will help) and put the rope through the pulley. Suspend the cable, keeping in mind that the pulley plus a short length of rope will cause the bait to hang lower. The bait can then be pulled up and the rope tied off to a tree. Attach a laminated card with the following message to a nearby tree, positioning it out of view except when close to the set:

This is part of an important wildlife study being conducted by _____. Please do not touch. It is an automatic camera that will take a picture of an animal as it comes to the bait, and will not harm the animal. If you have any questions, please contact _____. Thank you.

Climb the camera tree and mount the camera at a location where it is no more than 3-4 m from the target point and sufficiently high in the tree to reduce its accessibility to people and animals (between 3-4 m). By pointing the camera slightly down to the target point, the sensor field will be shortened so that an animal will not trigger the camera before it is close enough to be illuminated by the flash. Secure the camera to the tree using the mounting bracket and lag bolts. Mount the bracket at the approximate angle and direction needed to have the camera point directly to the target point. The camera angle can be adjusted slightly after it is mounted in the tree.

To test that the sensor field is appropriate for the site, position the unit and turn it on without film in the camera. With one person in the camera tree, the other person should walk into the target area from different directions to determine where the sensors first trigger the camera. Adjust the sensor field by blocking part of the sensor with the magnetic strips provided so that the camera is triggered only when the person is near the target point and toward the center of the picture.

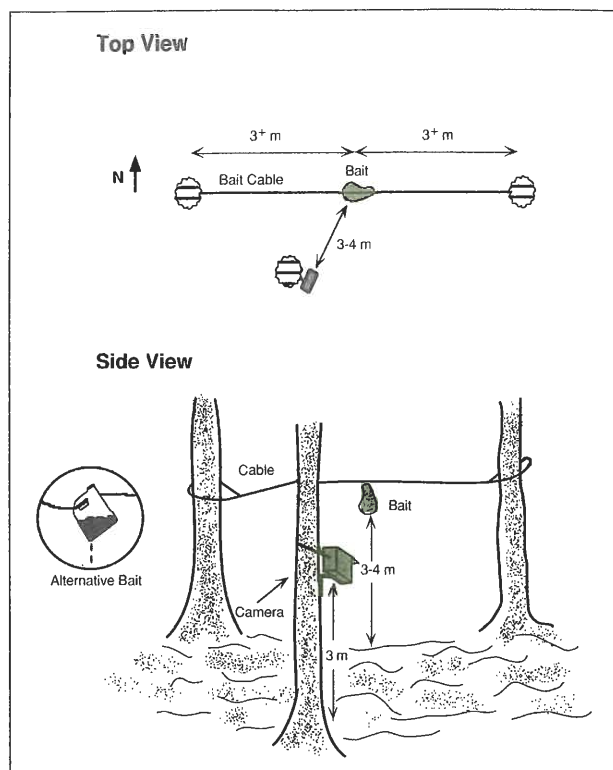


Figure 9—Schematic configuration of a dual-sensor camera station. Meat is used as an attractant, but blood baits can also be used.



Figure 10—Dual-sensor camera in position.

When the test is complete, load film in the camera and climb down the tree. With a black marker, write the station number on the back of a data sheet. Walk into the sensor field and trigger a single picture so that the station number will be identified in the photograph. Record in your field notebook the number of pictures taken during set-up, and the date and time of your departure from the site. A sketch of the site on the Survey Record form (*Appendix A* and in pocket inside back cover) including directions and approximate distances will help in evaluating the effectiveness of different configurations. Leave the site without walking through the sensor field. Write a short description of how to get to the site (a dot on an orthophoto-quad, topographic map, or aerial photo is extremely helpful), and flag the way to the site if necessary, but do not flag the site itself to lessen the chance of its being found by people.

Line Trigger

These stations are most easily established with two people, one setting up the mounting stake and camera and the other preparing the bait. If only one person is available, the camera portion should be assembled and in place before bait is handled to avoid transferring scent to the camera unit (Jones and Raphael 1993). Avoid putting stations in direct sunlight; light can penetrate these cameras. Remove vegetation so that the camera has an unobstructed view of the bait and the monofilament line is not obstructed (*figs. 5, 6*). Dig a hole about 6 inches deep for the mounting stake, put the bottom of the stake in it, and tap the soil around its base firmly to secure it. Rocks can be used for additional support or to help adjust the angle of the stake.

Load the camera with 12-exposure, 100-ASA, 110 print film, and advance it to exposure 1. Twenty- or 24-exposure film is also satisfactory but will leave more unexposed film. The date and station number should be identified on each film cartridge *before it is loaded into the camera* to avoid confusing the rolls when they are removed. This is important because there will probably be at least six cameras per sample unit. Attach the unit to the camera platform with Velcro, and if necessary, place the cut milk jug over it to protect it from rain.

Tie the monofilament line (> 20 lb test) to the 2-lb test trigger line, feed the former through the eye screws and ground wire to the washer on the “bait side” of the ground wire (figs. 5, 12). After attaching the line to the washer, move the ground wire away from the camera until the line is taut. The washer should be between 4 and 8 feet from the mounting stake. The second person should tie a strand of thread around the chicken and then tie the thread to the washer, leaving no more than 1 inch between the bait and the washer. Time can be saved by tying thread to all the chicken pieces you will use during the day before going into the field.

Do not rely only on the viewfinder to aim the camera. The aim will differ with the position of the observer's eye. Like all other aspects of setting up a camera, aiming should be practiced before the cameras are set up in the field. Some technicians find that the camera is properly aimed when, viewing from the bait, the operator can see neither the top of the camera nor the bottom of the platform. Others sight the bait so that it is in the lower third of the viewfinder. Still others use a length of line stretched from stake to bait to determine horizontal alignment, and straight up from the bait for vertical alignment. Placing the bait slightly uphill from the camera or angling the mounting stake slightly toward the bait will usually help center the bait in the photograph. Attach a laminated information slip with the following information to each camera stake:



Figure 11—Dual-sensor station. Camera (in box) on left and blood bait in jug suspended from line.



Figure 12—Bait attachment to ground wire, line-triggered camera system.

This is part of an important wildlife study being conducted by _____. Please do not touch. It is an automatic camera that will take a picture of an animal as it comes to the bait, and will not harm the animal. If you have any questions, please contact _____. Thank you.

When you consider the camera “set” in the field, take one or two test shots, holding a label card (a piece of 8 × 8-inch paper with the camera number, date, and station number indicated in large print) in view of the camera. Record in your field notes the number of test shots and the exposure number on which the camera is set when you leave, and then transfer this and other general information onto the Line-Triggered Camera Results form (*appendix A* and in pocket inside back cover).

Checking the Stations

Recommendations:

35-mm systems: Check the station four times at 7-day intervals so that it is operating 28 days *or* until the target species is detected. Allow extra days to achieve the minimum survey period if the station becomes inoperative. Pay particular attention to tracks in the snow near the station every time you check it.

Line-triggered system: Stations should be set for a minimum of 12 nights and checked every other day for at least six visits (excluding setup) *or* until the target species is detected. If the target species is not detected during the first 12-day session, run a second session during the alternate season (either spring or fall) for

12 days *or* until the target species is detected. Allow extra days to achieve the minimum survey period if the station becomes inoperative.

Single Sensor

The station should be checked at weekly intervals to ensure that it is working and that a non-target animal such as a squirrel has not immediately found it and used all the film. Weekly checks are also necessary to check the camera batteries which can discharge rapidly during cold winter conditions (Foresman and Pearson 1995). The station should be checked at least four times at weekly intervals, so that it is operating for 28 days.

Before you leave to check a station, be sure you have new bait and replacement film and batteries, Camera Results form (see *appendix A*, and in pocket inside back cover), contact cleaner and brush, and equipment for recording tracks in snow (see Chapter 5). Be familiar with the tracking material in Chapter 5. This is important. J. Copeland (pers. comm.) detected wolverine visits to photographic bait stations more frequently by tracks in snow than by photographs. Do not go alone, do check the weather, and bring appropriate gear. A list of equipment is provided below.

When you approach the set, look for and identify, describe, measure, photograph, and collect, as appropriate, tracks, scat, or any other sign of what may have been there. Note whether the bait is still present, whether it has been consumed, etc. Has the tree been scratched up, or have any string or wires been chewed or broken? Record these observations on the 35-mm Camera Results form (*appendix A*, and in pocket inside back cover).

Press R/O ADV to cycle through the “events” (i.e., interruptions of the beam). Record on the Camera Results form the date, event number, and time of only those events that caused a photograph to be taken (i.e., those that show a period between the first and second digit locations on the receiver’s display; see “Displays” section of the Trailmaster manual). If you miss something, cycle through the data again.

After recording the event data you will know how many frames were exposed. Replace the film if half or more of the frames were shot, or if you suspect from tracks or other sign that a target species has been at the set. To rewind a roll of film before its end, press the rewind button on the bottom of the camera gently with a ball-point pen. Immediately upon removing the film, write the station code and date on it with a marking pen, and put it into a film canister to keep it dry. Check the three electrodes on the camera cable for corrosion, and clean them if necessary.

With the Yashica camera, replace the two AA batteries after 1–2 weeks in the field. Avoid getting moisture or any other contamination in the battery or film compartments, or on the rubber seals; remove any moisture with a cotton-tipped swab. The Olympus cameras have a battery display on the LCD panel when the lens cover is opened. A solid battery figure indicates that the batteries are good; an outline of a battery, either flashing or on continuously, means that the batteries must be changed. Replace them with one (Infinity Mini DLX) or two (Infinity Twin) “DL123A” or “CR123A” lithium batteries. With the Infinity Mini DLX, check the day and time display to be sure it is still correct after changing the battery.

The batteries in the Trailmaster transmitter and receiver will last for 30 days in the field. When the batteries in the transmitter are low, the red indicator light on its base will immediately come on and quickly turn off when the unit is turned off; the light will stay on, or will not flash, when the unit is turned on. The receiver has a **L o b** (“low on batteries”) display and will not record events if the batteries are low. If the batteries have been in use more than 20 days, or if either the transmitter or receiver indicates low

batteries, replace the batteries in both units with four new alkaline C-cells. Do this over a jacket or cloth to avoid losing the tiny hex screws or wrench when you drop them into the snow or forest litter. Always replace batteries in both units at the same time. Before replacing the backs of the transmitter and receiver, make sure the rubber-gasket seals are seated in the groove, and that there is no moisture or other contamination on them.

If you are going to keep the station in place, replace and align the transmitter, receiver, and camera as necessary. Clean the camera lens with lens tissue and fluid if it is dirty. Clear the events from the receiver. Take a test photo to determine that all is operating correctly, and record the frame and event numbers left on the units when you leave.

If you find that a bear, coyote, or gray fox (*Urocyon cinereoargenteus*) has found the station and has been frequently returning, move the station at least 0.5 miles from the first location. If smaller animals such as birds or squirrels are triggering the camera, move the beam farther below the bait or out from the tree so that smaller-bodied animals do not break it. Check to see that no branches that may serve as perches remain near the beam.

Dual Sensor

Stations should be checked 4 times at weekly intervals. When checking a station, have all the gear necessary to establish one, including extra film and batteries. A spare camera unit or two will allow you to replace faulty ones if necessary. Bring equipment for recording tracks (see Chapter 5). Be familiar with the tracking material in Chapter 5. This is important. J. Copeland (pers. comm.) detected wolverine visits to photographic bait stations more frequently by tracks in snow than by photographs.

When you approach the set, look for and identify, describe, measure, photograph and collect, as appropriate, any tracks, scat, or other sign of which animals may have been to the station. Has the bait or scent been disturbed? Has the bait tree or camera tree been climbed? Record these observations on the Camera Results form (*appendix A* and in pocket inside back cover).

Enter the sensor field with the station sign, and trigger a single picture. Climb the camera tree, turn the unit off, and open the box. Record the frame that the camera is on. If the roll is more than half exposed, or if you suspect that a target species has visited the station, remove the film. Using a digital pocket battery tester, test both the 12-v battery and camera battery, and change them if they are low (this will depend on how long the unit has been out and when you plan to visit the site again). Remember, new, fully charged batteries will probably need recharging after 20 days, so you will probably need to replace the batteries after 1–2 weeks. Put new film in the camera if needed, check the batteries, hook the unit up, and turn it on just before you climb down the tree. Enter the sensor field with a sign indicating the station number and date, and expose a single picture. Leave the site without again entering the sensor field.

Line Trigger

When checking the camera, first determine whether the film can be advanced. If so, a photograph has been taken since the last visit. Record this and other information on a copy of the Line-Triggered Camera Results form (*appendix A* and in pocket inside back cover). Examine the camera unit, and note whether the camera is functional. Reasons for non-functional cameras include the thread being chewed through, the monofilament line obstructed or broken, and misattachment of the trigger line. To verify that the unit is functional, take a test photograph at every visit. To save processing costs, take this test shot with your hand blocking the lens so that no print will be developed from this exposure. Replace the bait at every visit. Initially, replace the film after one or two exposures (excluding test shots). Once the crew is familiar with the operation of the camera and the area appears safe from vandalism and persistent bear damage, the film

can be left in the camera longer. If the film is to be removed, make certain to advance it to the end of the roll before removing the cartridge. Failure to do so will result in the overexposure of the last few photographs and loss of data. Before leaving the station, make sure to advance film to the next exposure. If necessary, take additional test shots with the lens blocked to test the camera operation. Other general suggestions for checking line-triggered cameras are outlined in Jones and Raphael (1993).

Developing Film

When you remove exposed film from a camera, label it with the station number and date so that it will not be confused with other rolls. Fine-tipped, indelible markers work best. Often the least expensive developing is provided by large discount or drug stores, which typically make two prints of each exposure. Record the camera number, station number, and time period over which the film was exposed on the processing envelope *and* on the receipt. When using 110 film, if a custom-processing laboratory is available, have a contact sheet printed first. Review each frame on the sheet, and if possible, request that only those photographs that contain animal subjects be printed at full size. If custom processing is not available, and the budget is especially tight, have the negatives developed first and then select for printing only those frames that, when examined under a lens, contain an animal subject. However, there is a danger of missing something important if just the negatives are examined.

Label the back of each photograph with the species, date, and station. This same information should be entered on the Camera Results form. Archive all photographs in protective plastic covers. Examples of prints from 35-mm and 110 camera systems are presented in *appendix C*.

Data Management

We recommend three forms for data: Survey Record, Camera Results (different for 35-mm and line-triggered systems), and Species Detection form (*appendix A* and in pocket inside back cover). In wet areas or during snowy seasons, we strongly recommend using indelible ink and photocopies of the data sheets made on waterproof paper. All forms should be stored with photographs in a 3-ring binder as a permanent, complete record of what was done, where, when, by whom, and what the results were. Record all species detected. Your survey efforts can contribute to understanding the distributions of a variety of species in addition to MFLW.

Survey Record Form

This form contains information on each survey's location and details on its configuration. It is important to identify the legal description *and* the Universal Transverse Mercator (UTM) coordinates at each station. Collectively, these forms become a record of all the surveys conducted in the administrative area, regardless of their outcome.

Camera Results Form

Single and Dual Sensor

When checking stations using either the single-sensor system or the Trailmaster dual sensor, fill in the Date, Event, Number, and Time columns in the field as you cycle through the Readout/Advance mode. Record data only for those events associated with a picture, which is indicated by the decimal point between the first and second digits on the receiver's display. Fill in the Contents section after the film is developed, noting any species present.

When checking the stations using the dual-sensor system made by Manley, record in the comments section the number of frames exposed. When the film is developed,

record the Date, Time, and Contents of each exposure by examining the prints. Ignore the Event column.

In a 3-ring binder, store the data sheets, negatives, and prints by sample unit and station. Put the negatives and prints in plastic sleeves made for storing film.

Line Trigger

Use this form when establishing and checking the line-triggered camera stations. Use a separate sheet for each day, and record information for each camera visit whether an exposure was taken or not. Record the station number, the camera number, and the exposure number (at both your arrival and your departure from the station) at each visit. Record the visit number (0 for setup, and 1-6 for station visits) and the number of nights since the last visit (should be two in most cases). Note also whether a photo was taken since the last visit and the number of test shots taken at each check. The species recorded will be determined after the film is processed, so that space will remain blank until later. Remember, do not terminate effort on the sample unit until the film is developed and you are certain the target species was photographed.

Species Detection Form

When a survey is successful at detecting marten, fisher, lynx, or wolverine, complete the Species Detection form, which characterizes successful surveys and is used for all methods (camera, track-plate, snow-track). Complete one form for each species detected. Submit one copy to the state Natural Heritage office (addresses provided in Chapter 1), and archive a copy at the office of the agency that manages the land where the survey was conducted. Most Natural Heritage databases record only positive results from detection surveys.

Comparisons of Camera Systems

The perfect remote camera system is yet to be developed. In this section we discuss some of the strengths and weaknesses of each of the camera systems described to allow investigators to decide which may be most appropriate for their circumstances.

The first major difference between 35-mm and line-triggered systems is in the cost of the equipment. The 35-mm systems cost \$500-\$600, and the line-triggered systems less than \$25. This substantial difference in initial price, however, may be mitigated by differences in labor involved in the construction of the equipment and the frequency of checking the stations. The 35-mm systems require virtually no assembly upon receipt from the manufacturer. The line-triggered system must be built by the user. Because the 35-mm systems can shoot an entire 36-exposure roll of film, they may be left in the field longer without being checked than the line-triggered systems, which can take only one picture and then must be rebaited and reset. However, damage or loss from vandalism, theft, or bears is more serious with the 35-mm systems than with the line-triggered system. Both of the 35-mm systems can be more readily used in severe weather, especially winter, than the line-triggered cameras.

Another difference between the two types of camera system is the triggers. The 35-mm systems use infrared (single sensor) or infrared and microwave (dual sensor) triggers, which require only that an animal be near the bait to be photographed. In contrast, animals must physically pull the bait to be photographed by the line-triggered system. In addition, the sensitivity of the triggers on several of the 35-mm systems is adjustable, and the film displays the date and time. The line-triggered camera lacks these features. Jones and Raphael (1991) found that half of all photos taken by line-triggered cameras did not record a subject and that 65 percent of these problems were due to failure of the disposable ("flip") flash. However, the 110 camera recommended here has an internal flash that rarely fails.

Of the 35-mm systems we discussed, the Trailmaster TM1500 allows the user to specify the minimum length of time between photographs to lessen the probability that one animal will expose most of the film. Although this is not possible with the Manley dual-sensor model, the dual sensor made by Trailmaster (TM500) does have this feature. With the single-sensor camera system the animal must break a narrow infrared beam. The dual-sensor system requires only that an animal come into the field, up to 11 m from the camera. However, dual-sensor systems may be triggered when the sun heats up the background, so it is best to use them in cold conditions. The TM1500 uses eight alkaline "C" cells; the Manley dual sensor uses a heavier 12-volt battery, which is more difficult to transport. Some 12-volt batteries may leak; gel-cell batteries that do not leak can be used but at greater expense. The difference in batteries accounts for the approximately 10-kg difference in the weight of the two systems. Both Trailmaster models store the date and time of all "events." The Manley dual-sensor system is housed in a metal box, which affords some protection from weather and bear damage and can be modified to be locked shut and cabled to a tree to help prevent theft and vandalism.

Other commercially available products may resolve some of the problems with dual-sensor systems. The Trailmaster TM500 uses four alkaline C-cells, and the Deerfinder uses six D-cell and two AAA batteries, which results in much more portable systems. The TM500's batteries last several months in the field. These dual-sensor systems also allow the programming of a camera delay and store the date and time of up to 1000 (Trailmaster) or 495 (Deerfinder) events. We do not yet have extensive field experience with these systems, but preliminary results from simultaneous use of the Manley and TM500 dual-sensor systems indicate great advantages of the lighter weight, ability to program a camera delay, and storage of event data provided by the TM500 (K. R. Forseman, pers. comm.). The TM500 also allows adjusting of the sensitivity of its dual-sensor trigger, which may prevent small, non-target species from triggering the camera.

Remote video technology also is advancing, and video has several obvious advantages over still photography. Video tape does not require developing, and it may be used repeatedly. Video systems allow continuous photographic monitoring rather than a "snapshot," and can record several hundred "events," rather than the 36 events possible on a standard roll of film. Trailmaster offers a modified Sony Handycam camcorder to be used with the Trailmaster TM700v. A dual-sensor monitor turns the video camera on when it detects motion and heat, and turns the camera off when the animal moves out of range of the sensors. The tape lasts 2 hours, and the system stores the date and time of up to 1000 events. Other remote video systems are available from Compu-Tech Systems. Remote videography has been used to detect fishers in Oregon (S. Armentrout, pers. comm.; F. Wahl, pers. comm.). We have had no experience with these systems, however, and their cost (several thousand dollars) will probably prevent their common use in detection surveys.

In summary, the line-triggered system is inexpensive but requires more labor and is less versatile and rugged than the 35-mm systems. Once the bait is taken, the camera must be reset for another picture; date and time are not displayed on the film. The 35-mm systems are initially expensive, but require no assembly and because they can shoot an entire roll of film, they require less labor. The single-sensor's trigger requires precise placement of the system and can be adjusted for sensitivity. The Trailmaster allows the minimum interval between pictures to be set by the user and electronically stores the date and time of each event. Dual-sensor systems can detect animals over a broader field, the size of which is somewhat adjustable. The Manley dual sensor uses a heavy, 12-v battery, does not allow a minimum interval between photographs to be set, does not store the date and time of events, and is housed in a metal box that provides mechanical protection and may be locked. All Trailmasters operate with alkaline C-

cells. The TM500 dual sensor allows specification of a minimum interval between photographs of 1 to 98 minutes, stores the date and time for up to 1000 events, and allows adjustment of the sensitivity of the trigger.

Costs

Assumptions for 35-mm systems:

- Five adjoining sample units, 4 mi² each, are surveyed.
- Five camera systems are available. Dual-sensor stations use Manley systems.
- There are two stations per sample unit for a total of 10 stations; stations will be established in two sessions of five stations each.
- There is one survey per year, in winter; each station operates for 30 days; the station is visited after 2 and 14 days and is removed after 30 days. No target species is detected.
- The work is conducted by a team of two federal employees paid at \$75.00/person/day. No contractors are used.
- All sample units have adequate road access.

Single Sensor

Session 1

1. Labor

Planning	2 person-days (pd)	
	2 pd × \$75 =	\$150
Training	2 pd × \$75 =	150
Establish stations, 1 station/pd	5 pd × \$75 =	375
Station visits, 4 visits/station	0.5 pd/visit 5 stations	
	10 pd × \$75 =	750
Data analysis	4 pd × \$75 =	300

Subtotal for Session 1 Labor 1725

2. Vehicles and Gas 300

3. Materials and Supplies

Trailmaster TM1500	5 @ \$550 =	2750
Film and processing	10 rolls @ \$15 =	150
Batteries, miscellaneous		200

Subtotal for Session 1 Materials 3100

Session 1 Total **\$5125**

Session 2

1. Labor - Same as for Session 1 1725

2. Vehicles and Gas - Same as for Session 1 300

3. Materials and Supplies

Film and processing	10 rolls @ \$15 =	150
Batteries, miscellaneous		200

Subtotal for Session 2 Materials 350

Session 2 Total **\$2375**

Grand Total - Single Sensor **\$7500**

Dual Sensor

Session 1

1. Labor - will be same as for single sensor	\$1725
2. Vehicles and Gas - same as for single sensor	300
3. Materials and Supplies	
Dual-sensor remote cameras	5 @ \$ 475 = 2375
12-volt batteries	10 @ \$ 40 = 400
Film/developing - same as single sensor	150
Camera batteries	8 @ \$ 8 = 64
12-volt battery charger	35
Pocket volt meter	30
Tree steps	10 @ \$ 3 = 30
Climbing safety belt	15
Ratchet/sockets	15
Brush clipper or pruning saw	15
Equipment for bait set-up	5
Subtotal for Session 1 Materials	3134
<i>Session 1 Total</i>	<i>\$5159</i>

Session 2

1. Labor - same as for Session 1	1725
2. Vehicles and Gas - same as for Session 1	300
3. Materials and Supplies	
Film and processing	150
Camera batteries	8 @ \$ 8 = 64
Misc. replacement equipment	50
Subtotal for Session 2 Materials	264
<i>Session 2 Total</i>	<i>\$2289</i>
<i>Grand Total - Dual Sensor</i>	<i>\$7448</i>

Line Trigger

Assumptions:

- Five adjoining sample units, 4 mi² each, are surveyed simultaneously for a total survey area of 20 mi².
- There are six stations per sample unit (a total of 30 stations) that are checked during the entire survey period, 12 nights.
- All sample units have adequate road access.
- It is assumed that no target species are detected during the survey. Because a survey is terminated when the target species is (are) detected, costs can be significantly less if the target species is detected early in the survey period.
- There are two surveys per year, during fall and spring.
- The work is conducted by a crew of federal employees paid about \$75.00/person/day. No contractors are used.

Season 1**1. Labor**

Planning	2 person days (pd)	
	$2 \text{ pd} \times \$75/ =$	150
Training	$2 \text{ pd} \times \$75 =$	150
Materials acquisition and construction ..	5 stations/day	
	$6 \text{ pd} \times \$75 =$	450
Establish stations 10 stations/pd	$3 \text{ pds} \times \$75 =$	225
Stations visits	6 at 2-day frequency	
	$6 \times 30 = 180 \text{ visits}$	
	20 stations/pd	
	$= 9 \text{ pds (including } \geq 1 \text{ Sunday @ time + 1/2)}$	
	$(8 \times \$75) + (1 \times 112) =$	712
Station removal, plate cleaning, data analysis	$4 \text{ pds} \times \$75 =$	300
Subtotal, Season 1 Labor		1987

2. Vehicles and Gas 700

3. Materials and Supplies

Camera stations	$\$15/\text{station} \times 30$	450
Extra cameras and miscellaneous supplies		250

Subtotal, Season 1 Materials 700

Season 1 Total **\$3387**

Season 2**1. Labor**

Plan, survey, establish, visit, and remove stations 1387

2. Vehicles and Gas 700

3. Materials and Supplies

Cameras	replace 15 percent of first season's stations $5 \text{ stations} \times 15 =$	75
Miscellaneous supplies		250

Subtotal, Season 2 Materials 325

Season 2 Total **\$2412**

Grand Total - Line Trigger **\$5799**

Equipment List

Single Sensor

- | | |
|--|---|
| ☐ Trailmaster transmitter and receiver | ☐ Cameras |
| ☐ Tree pod, or ball-and socket head | ☐ Spare allen screw |
| ☐ Bait and scent | ☐ Duct tape |
| ☐ Data forms | ☐ Push pins |
| ☐ Maps and aerial photos | ☐ Wire |
| ☐ Parachute cord/string | ☐ Pliers |
| ☐ 3x5 cards | ☐ Pruning saw |
| ☐ Flagging tape | ☐ Do-not-disturb signs |
| ☐ Spare batteries
(eight alkaline C-cells,
two 123A lithium camera) | |

- ☐ Film
- ☐ L-bracket and lag bolts
- ☐ Allen wrench and spares
- ☐ Contact cleaner and brush
- ☐ Copies of Trailmaster manuals
- ☐ Waterproof pen
- ☐ Cotton-tipped swabs
- ☐ Spare camera cable(s)

Dual Sensor

- | | |
|---|--|
| ☐ Cameras | ☐ Sensors |
| ☐ Camera batteries | ☐ 12-volt batteries |
| ☐ Flagging tape | ☐ Wire |
| ☐ Pocket volt meter | ☐ Tree steps |
| ☐ Nails | ☐ Bait and scent |
| ☐ Pruning saw | ☐ Station ID signs |
| ☐ Copies of camera and
sensor manuals | ☐ Waterproof pen |

- ☐ Camera boxes
- ☐ Film
- ☐ Maps and aerial photos
- ☐ Rope and climbing belt
- ☐ 1/8-inch cable for suspending bait
- ☐ Data forms

Line Trigger

- | | |
|---|---|
| ☐ Cameras | ☐ Film |
| ☐ Bait and scent | ☐ Data forms |
| ☐ Soap and water | ☐ 3 x 5 cards |
| ☐ Coat hanger for ground wire | ☐ Thread |
| ☐ Stereo wire | ☐ Soldering equipment |
| ☐ Velcro | ☐ Shovel |
| ☐ Silicone sealant | ☐ Duct tape |
| ☐ 2-lb and ≥ 20-lb monofilament line | ☐ Auxiliary battery pack |

- ☐ Mounting stake
- ☐ Milk jug
- ☐ Washers
- ☐ D-cell batteries
- ☐ Heavy rubber bands
- ☐ Fence staples or eye screws
- ☐ Electrical tape

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Appendix A—Data Forms

SURVEY RECORD FORM

SURVEY TYPE:

CAMERA _____ TRACK PLATE _____ SNOW TRACKING _____

Line Trigger _____ Enclosed _____ Searching for tracks _____

Single Sensor _____ Unenclosed _____ Tracking at bait _____

Dual Sensor _____

Other _____

SAMPLE UNIT NUMBER _____

Number of stations _____ or Distance searching for tracks _____

State _____ County _____ Landowner _____

Location _____ USGS Quad _____

Legal: T _____ R _____ S _____, _____, _____, _____.

STATION LOCATIONS:

UTM Zone _____

Station ID UTM N/S UTM E/W Elevation (ft. or m?)

(use another sheet if necessary)

Vegetation type (s) _____

Date installed (or run) _____ Date terminated _____

Type of bait or scent _____

Name, address, and phone of investigator _____

35-mm Camera Results

Date: _____

Station ID: _____

Comments (condition of site and bait, new batteries and bait, etc.): _____

Settings for TM 1500: Pulses _____ Camera Delay _____

TM 500: Pulses _____ Pt _____ Camera Delay _____

Date	Event ^a	Frame	Time	Contents
_____	_____	1	_____	_____
_____	_____	2	_____	_____
_____	_____	3	_____	_____
_____	_____	4	_____	_____
_____	_____	5	_____	_____
_____	_____	6	_____	_____
_____	_____	7	_____	_____
_____	_____	8	_____	_____
_____	_____	9	_____	_____
_____	_____	10	_____	_____
_____	_____	11	_____	_____
_____	_____	12	_____	_____
_____	_____	13	_____	_____
_____	_____	14	_____	_____
_____	_____	15	_____	_____
_____	_____	16	_____	_____
_____	_____	17	_____	_____
_____	_____	18	_____	_____
_____	_____	19	_____	_____
_____	_____	20	_____	_____
_____	_____	21	_____	_____
_____	_____	22	_____	_____
_____	_____	23	_____	_____
_____	_____	24	_____	_____
_____	_____	25	_____	_____
_____	_____	26	_____	_____
_____	_____	27	_____	_____
_____	_____	28	_____	_____
_____	_____	29	_____	_____
_____	_____	30	_____	_____
_____	_____	31	_____	_____
_____	_____	32	_____	_____
_____	_____	33	_____	_____
_____	_____	34	_____	_____
_____	_____	35	_____	_____
_____	_____	36	_____	_____
_____	_____	37	_____	_____

Left on Frame # _____ and Event # _____ at _____ hours

^a Only for cameras (e.g. Trailmaster) that store events.

General Comments _____

[illegible]

^e If no new exposure, enter a dash. If a photograph has been taken enter either the four-letter species code (eg. MAAM, for marten; NOSB, no subject; UNKN, unknown; or NULL, improper exposure) after the film has been processed.

SPECIES DETECTION FORM

Please complete each field after a survey has detected either lynx, wolverine, fisher, or marten, and send a copy to your state's Natural Heritage Division (addresses in Chapter 1) and other appropriate entities. The meaning of each code is explained on the following page. It is important to coordinate with the State Wildlife Agency/Natural Heritage Program within your State to assure uniform codes are used for federal lands, parks, private lands, counties, etc.

1. **SPEC** _____
2. **DATE** _____
3. **STATE** _____
4. **CO** _____
5. **LOC** _____
6. **QUAD** _____
7. **QUADNO** _____
8. **OWN** _____
- 8a. **FOR/PARK** _____
- 8b. **DISTRICT** _____
9. **RNG** _____
10. **TWN** _____
11. **SEC** _____
12. **QSEC** _____
13. **SIXTHSEC** _____
14. **M** _____
15. **Z** _____
16. **UTM_N** _____
17. **UTM_E** _____
18. **OBS** _____
19. **SVTP** _____
20. **STA_NO** _____
21. **TR_NO** _____
22. **ELEV** _____
23. **COMMENTS** _____

CODES FOR THE SPECIES DETECTION FORM

1. **SPEC** - Species; 1 letter: L = lynx, W = wolverine, F = fisher, M = marten.
2. **DATE** - Date; year, month, day; e.g., Jan. 12, 1994 = 19940112.
3. **STATE** - State; use 2-letter postal abbreviation, e.g., MT, OR.
4. **CO** - County; use 2-letter code, e.g., AP=Alpine, HU=Humboldt
5. **LOC** - Locale; the most specific names possible using names found on USGS maps, e.g., Grizzly Creek. 20 characters.
6. **QUAD** - Name of USGS topographic quad showing survey area; if >1, use additional sheets, e.g., Ship Mountain. 20 characters.
7. **QUADNO** - USGS quad number utilizing latitude and longitude identification system.
- *8. **OWN** - Landowner. 4-letter code, e.g., USFS, NPS, BLM, CA, PVT.
- 8a. **FOR/PARK** - National or State Forest or Park name. 3 characters.
- 8b. **DISTRICT** - Subdivision of Forest or Park (e.g., Ranger District if "OWN" = USFS. 3 characters.
9. **RNG** - Range. 3-characters.
10. **TWN** - Township. 3-characters.
11. **SEC** - Section. 2-characters.
12. **QSEC** - Quarter section. 2 characters.
13. **SIXTHSEC** - Sixteenth section. 2 characters.
14. **M** - Meridian. 1-character.
15. **Z** - UTM zone. 2-characters.
16. **UTM_N** - UTM-north coordinate; 7-characters.
17. **UTM_E** - UTM-east coordinate; 6-characters.
18. **OBS** - Observer; last name, first name, middle initial of survey crew leader. 20 characters.
19. **SVTP** - Survey type: SNSS = snow-tracking survey (searching); SNSB = snow-tracking survey (at bait); TRPL = track plate; CAMR = camera (35-mm or 110).
20. **STA_NO** - Station number of detection (if camera or track plate). 2 characters.
21. **TR_NO** - Number of snow transect where detection occurred. 2 characters.
22. **ELEV** - Elevation at detection site. 5 characters.
23. **COMMENTS** - 30 Characters.

* Each state will need to develop 2-3 character codes for specific forests, parks, private landowners and districts therein.

Appendix B— Trailmaster TM1500 commands

1. When first programming the unit, or after changing batteries, when all memory is erased: Press TIME SET then R/O ADV to advance to correct hour. Repeat this command to correct the following: minute, year (tens), year (ones), month, day of month, pulses, and camera delay.

To enable photographs at all times:

- ⊗ Press and hold TIME SET and press SET UP; **0:1n** should be displayed.
- ⊗ Press R/O ADV so that the display shows **1:1n**. (In fact, any non-zero digit is fine.)
- ⊗ Press TIME SET to cycle through the next 7 displays (e.g., **1n:00**, **0:1F**, etc.). All these should contain zeros; if they do not, press R/O ADV until they do contain zeros.
- ⊗ Press TIME SET, and the system will return to Time-Date-Time-Event (T-D-T-E) mode.

2. To read out event data:

- ⊗ Press R/O ADV once to see date of first event; press it again to see the event number and the time; press it again to see the next event number and the time.

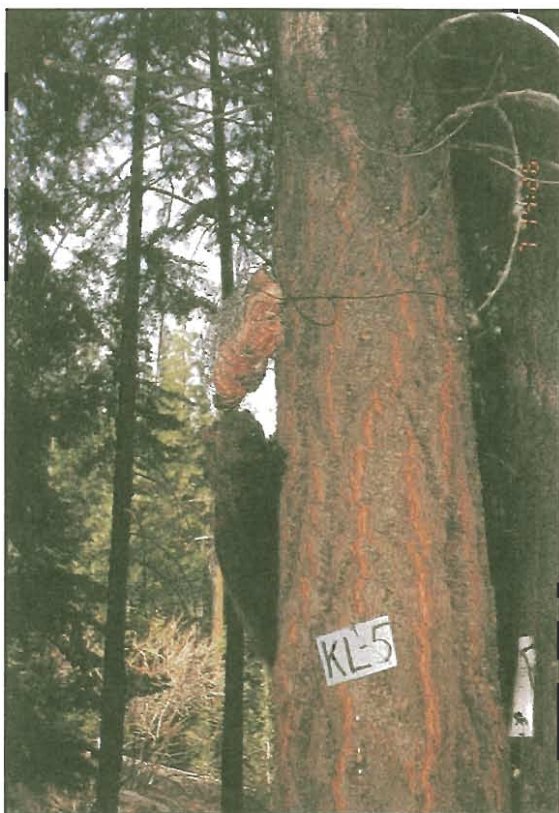
3. To clear event data (note: this does not change pulses or camera delay):

- ⊗ Press SET UP once or twice so that the display reads **S. uP.**, then press R/O ADV (the display will show **clr**), then press TIME SET. The system shows zero events and automatically goes into event-gathering mode. If you do not want to clear the data when the display reads **clr**, press R/O ADV and it returns to setup mode, or press SET UP and it returns to T-D-T-E mode.

4. To put receiver into Event Gathering Mode:

- ⊗ With **S. uP** or **clr** displayed, press TIME SET.

Appendix C



A. Fisher; Klamath National Forest, California. Single-sensor camera.



B. Fisher; Six Rivers National Forest, California. Single-sensor camera.



C. Marten; Sierra Nevada, California. Single-sensor camera.



D. Marten; Sierra Nevada, California. Single-sensor camera.



E. Lynx; Montana. Dual-sensor (Manley) camera.



F. Wolverine, Sawtooth National Forest, Idaho. Dual-sensor (Manley) camera.



G. Wolverine, Sawtooth National Forest, Idaho. Dual-sensor (Manley) camera.

H. Marten, Sequoia National Forest, California, Line-trigger camera.



I. Marten; Sequoia National Forest, California. Line-triggered camera (note enclosed track plate box in background).





J. Fisher; Six Rivers National Forest, California. Line-triggered camera.



K. Fisher; Sequoia National Forest, California. Line-triggered camera.



L. Juvenile fisher, Six Rivers National Forest, California. Line-triggered camera.

